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OIL FLOW I PIPE LINES

By R. S. RTH
ASSOC. N

COMPRISING HOWING
THE PRESSURE LOSS IN NT SIZED PIPE LINES
THE CONVERSION O' OMETER READINGS
THE HORSE POWER RED FOR PUMPING

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PR[illegible]FACE

[illegible] problems [illegible] following charts are [illegible] method of computation used by the [illegible] Pressure Loss in Oil Pipe Lines" pub- [illegible] Company of Boston, Massachusetts, [illegible] liquids in pipe lines as deduced by [illegible] Pannell of the National Physical Lab- [illegible] med by other investigators.

[illegible] of variation in the pressure loss in [illegible] roughness of pipes used in pumping oil, [illegible] experiments show that the pressure loss [illegible] relied upon within the limits of error [illegible] nation of [illegible] conditions.

[illegible] knowledgment in addition to those in the original bul- [illegible] Mr [illegible] nel of the U. S. Bureau of Standards.

R. S. DANFORTH

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INSTRUCTIONS

On each chart the solution of an example is shown by a dotted line with arrows

PRESSURE LOSS CHARTS

The vertical lines represent the quantity of oil to be pumped in barrels per hour or in gallons per minute.

The sloping lines represent the Saybolt Universal Viscosity of the oil at the given temperature and the corresponding kinematic viscosity (u/g), which is the absolute viscosity (u) in poises (the c g s unit), divided by the specific gravity (g). The values of the kinematic viscosity are shown in parenthesis following the Saybolt values.

Example of Determination of Pressure Loss When Quantity, Viscosity and Baumé Gravity are Known

2" Standard wrought iron or steel pipe.
5.5 barrels per hour or 3.8 gallons per minute quantity.
500 Saybolt viscosity and 24° Baumé gravity (modulus 140) at the temperature at which the oil is being pumped.

Locate the intersection of the vertical line representing 5.5 barrels per hour (or 3.8 gallons per minute) with the sloping line representing 500 Saybolt viscosity. Project this point of intersection horizontally to the line EF and from this point proceed on the sloping extension of the horizontal line until this intersects the vertical line representing 24° Baumé gravity.

Proceed then on a horizontal line to the left border of the chart to read the resulting friction pressure loss of 5¾ lbs. per square inch per 1000 feet of pipe line.

Example of Determination of the Quantity When the Pressure Loss, Viscosity and Baumé Gravity are Known

Locate the given friction pressure loss of 5¾ lbs. per square inch per 1000 ft. of pipe line at the left hand border of the chart. Proceed horizontally to the right until intersecting the vertical line representing 24° Baumé gravity, then follow up the sloping extension until this intersects the line EF.

Proceed then horizontally to the right until intersecting the sloping line representing 500 Saybolt viscosity. Project this point of intersection vertically to the top or bottom of the chart reading the resulting quantity of 5.5 barrels per hour or 3.8 gallons per minute.

Discussion of Pressure Loss Charts

The sloping viscosity lines shown on the charts represent three phases of flow.

The solid lines represent the condition of so-called stream line flow during which the oil flows in parallel lines through the pipe with no turbulence, the oil at the center of the pipe flowing at approximately twice the average velocity and the velocity decreasing to practically zero at the outside.

The intervening dash lines indicate the phase of the critical velocity where the flow changes suddenly from stream line to turbulent flow.

The dotted lines indicate the phase of turbulent flow during which the oil whirls and eddies in all directions.

In the 8 inch, 10 inch and 12 inch sizes more than one weight of standard iron and steel pipe is in common use but the charts are based on the following weights: 8" — 28.8 lbs per ft., 10" — 41.1 lbs per ft., 12" — 50.7 lbs per ft. Should the lighter weights be used the pressure loss would be slightly less.

The charts will apply to the flow of any liquid or gas where the inside surface of the pipe is of the same roughness as ordinarily used in oil work.

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Cautions

In the case of pumping heated oils in stream line flow an increase of pressure loss should be allowed to cover uneven distribution of temperature across the cross section of the pipe line. This allowance should be under 20 per cent for the usual installation.

Allowance should always be made for the excess pressure loss due to fittings. An approximate rule is to increase the length of pipe line by 30 times the pipe diameter in feet for each elbow, 60 times for each tee, 11 times for each gate valve, 40 times for each angle valve and 90 times for each globe valve.

VISCOSITY CONVERSION CHART "E"

The time of efflux or discharge of any of the commercial viscometers corresponds to a definite value of the kinematic viscosity (u/g). Chart "E" shows the conversion of the times of efflux of the Saybolt Universal, Engler, Redwood, Redwood Admiralty and Saybolt Furol viscometers and Engler Specific viscosity into kinematic viscosity. The charts for Saybolt Furol and Redwood Admiralty conversions are based on approximate formulae given by Mr. W. H. Herschel of the U. S. Bureau of Standards as the best available as of May, 1921.

To determine the absolute viscosity from the kinematic viscosity the lower section on Chart "E" may be used as shown by the following example.

Kinematic viscosity, 0.27.

Baumé Gravity, 26.5 (at temperature of test). Locate the value 0.27 of the kinematic viscosity on the top line of this section. Proceed downward parallel with the sloping lines to an intersection with the horizontal line representing the value of 26.5° Baumé gravity. From this intersection proceed vertically to the top line of the section reading the resulting value 0.24 of the absolute viscosity. The process may be reversed to determine the kinematic viscosity if the absolute viscosity is known.

Below this chart is a diagram showing the conversion of barrels per hour into corresponding gallons per minute.

Plotting the absolute viscosity of an oil against the corresponding Farenheit temperature on logarithmic cross section paper will usually give an approximately straight line.

HORSE POWER CHARTS

The horizontal cross section lines represent the value of the total pumping head, that is the suction lift plus the discharge pressure both in pounds per square inch. Both the static head and the friction pressure loss in pipes, fittings and valves should be included. The sloping lines represent the capacity in barrels per hour or in gallons per minute according to the chart used. The horizontal cross section lines below the line HK represent the combined efficiency of pump and drive. The values at the bottom of the chart give the shaft horse power required.

Below the charts are diagrams showing the conversion from barrels per day to barrels per hour, and from cubic feet per second to gallons per minute.

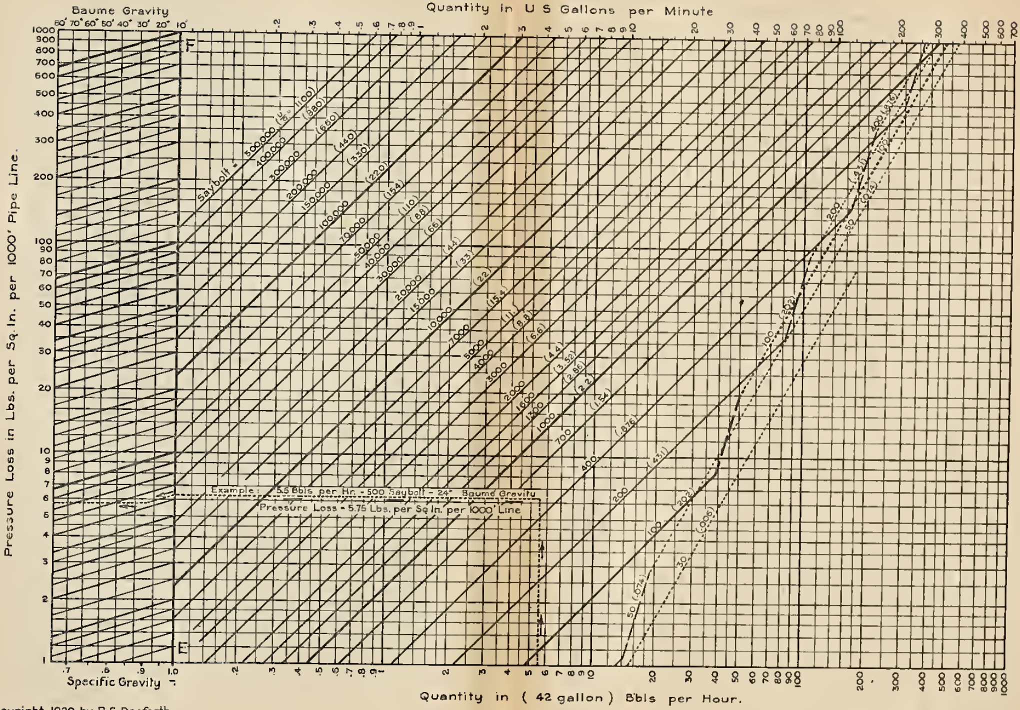
Example of Determination of Horse Power When Pumping Head, Quantity and Efficiency are Known

Suction lift plus discharge head, 110 pounds per sq. in.
Quantity pumped, 1200 barrels per hour.
Efficiency of pump and drive, 50 per cent.

Locate the intersection of the horizontal line representing 110 lbs. per square inch head with the sloping line representing 1200 barrels per hour capacity. Project this point of intersection vertically downward to the line HK.

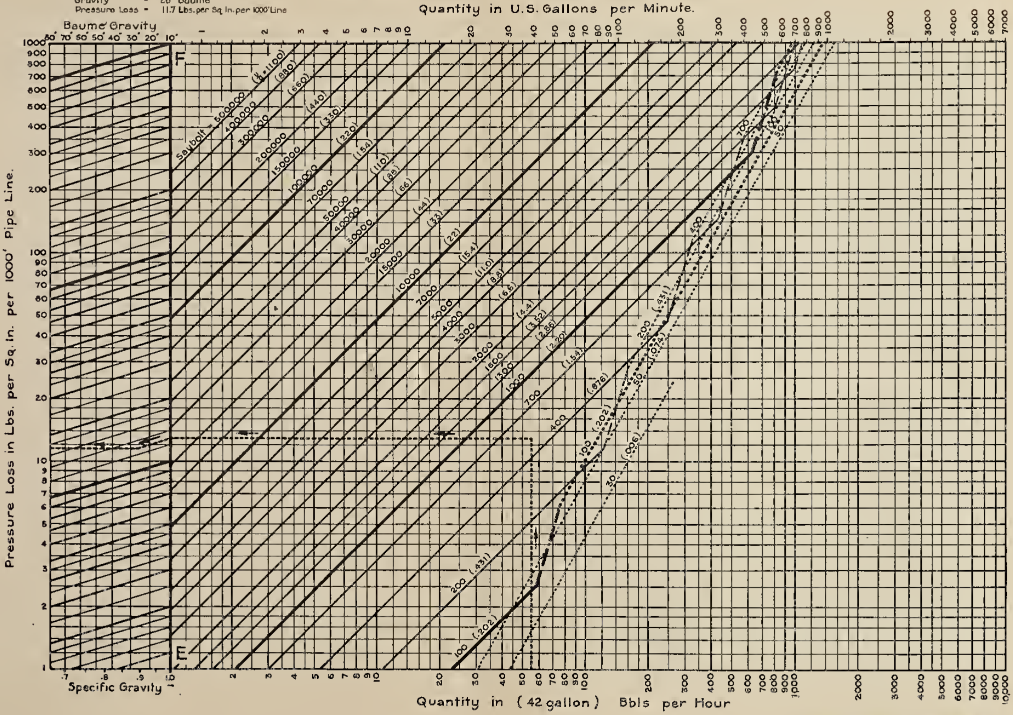
Proceed then parallel with the downward sloping lines to an intersection with the horizontal line representing 50 per cent mechanical efficiency of pump and drive. Project this point of intersection vertically downward to the bottom of the chart reading the value of 108 shaft horse power required.

2" STANDARD IRON & STEEL PIPE.



Example:(shown by dotted line with arrows)
Quantity - 55 Barrels per Hour
Viscosity - 500 Saybolt
Gravity - 28° Baume'
Pressure Loss - 11.7 Lbs. per Sq. In. per 1000' Line

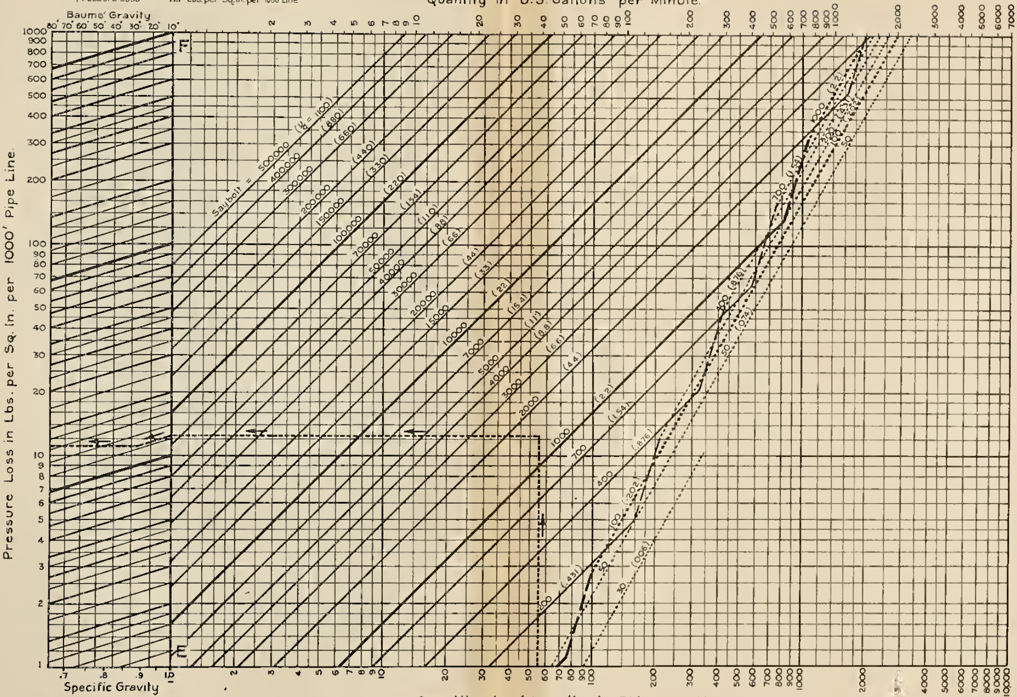
3" STANDARD IRON & STEEL PIPE.



4" STANDARD IRON & STEEL PIPE.

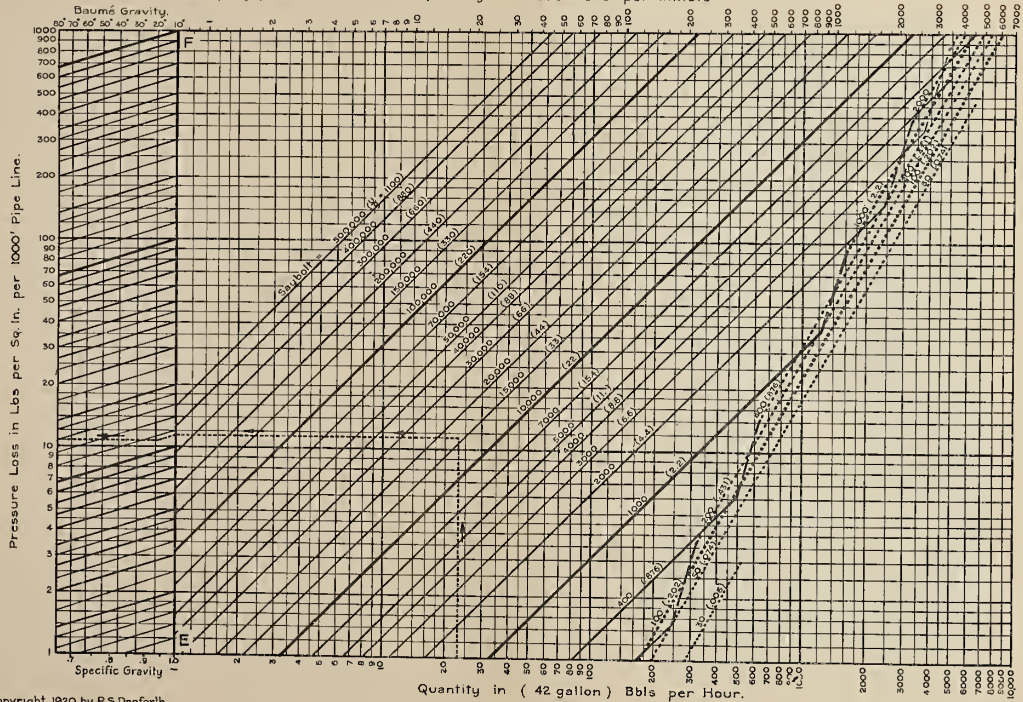
Example (shown by dotted line with arrows)

Quantity = 55 Barrels per Hour
Viscosity = 1400 Saybolt
Gravity = 26° Baume'
Pressure Loss = 11.1 Lbs. per Sq. In. per 1000' Line



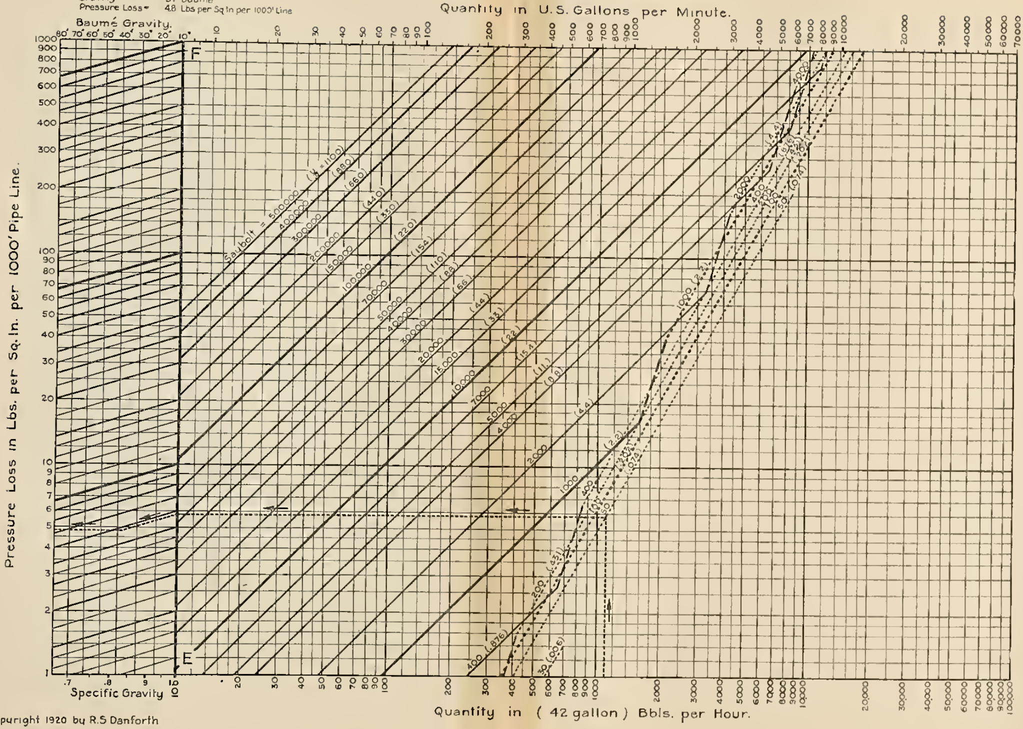
Example:(shown by dotted line with arrows)
Quantity - 23 Barrels per Hour
Viscosity - 16,000 Saybolt
Gravity - 18° Baume'
Pressure Loss - 10.8 Lbs. per Sq. In per 1000' Line

6" STANDARD IRON & STEEL PIPE



Example (shown by dotted line with arrows)
Quantity = 1100 Barrels per Hour
Viscosity = 50 Saybolt.
Gravity = 37° Baume°
Pressure Loss = 4.8 Lbs per Sq In per 1000' Line

8" STANDARD IRON & STEEL PIPE



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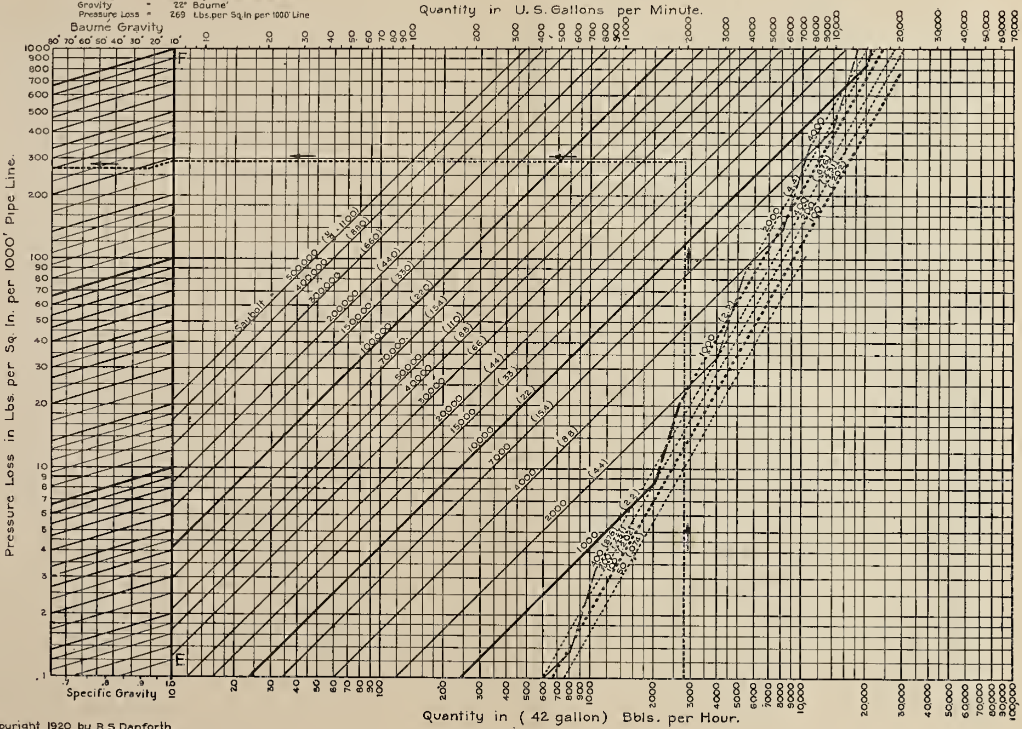
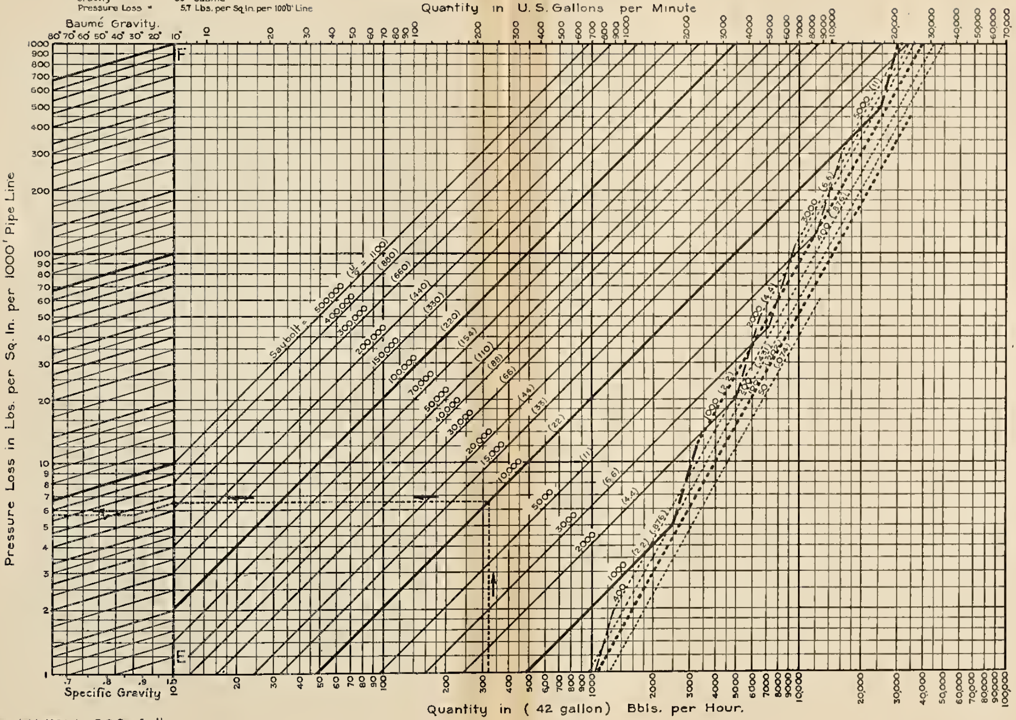
10" STANDARD IRON & STEEL PIPE.

Example: (shown by dotted line with arrows)
Quantity = 2800 Barrels per Hour
Viscosity = 25,000 Saybolt (55 Kinematic)
Gravity = 22° Baume'
Pressure Loss = 269 Lbs. per Sq. in per 1000' Line

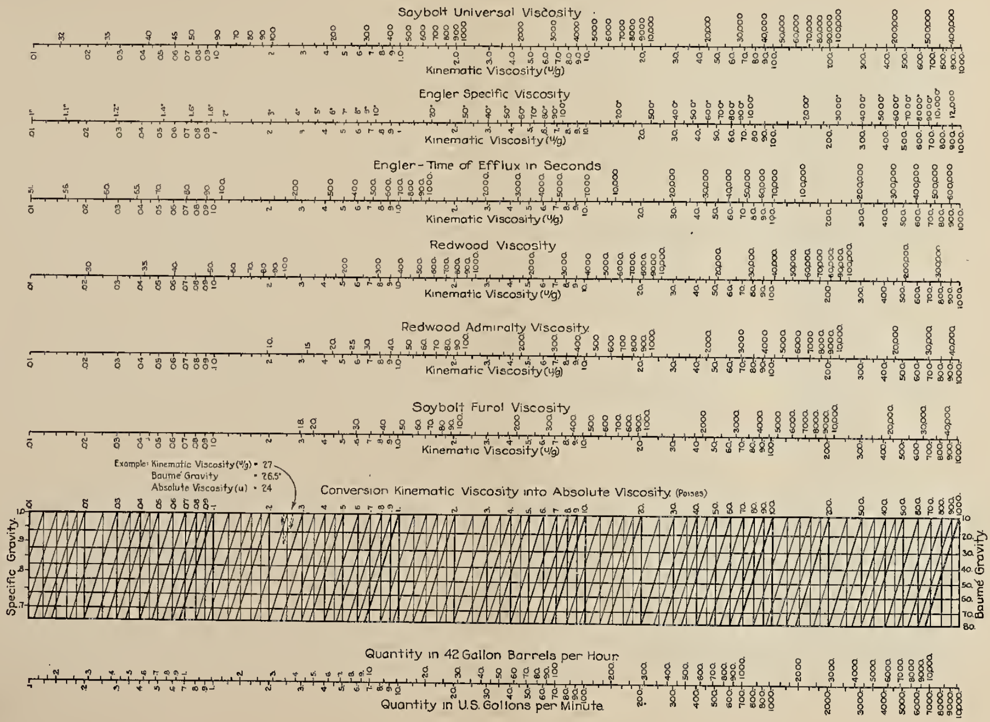


Example:(shown by dotted line with arrows)
Quantity - 320 Barrels per Hour
Viscosity - 10,000 Saybolt
Gravity = 30° Baume'
Pressure Loss = 5.7 Lbs. per Sq. In. per 1000' Line

12" STANDARD IRON & STEEL PIPE.



VISCOSITY CONVERSION CHART "E"



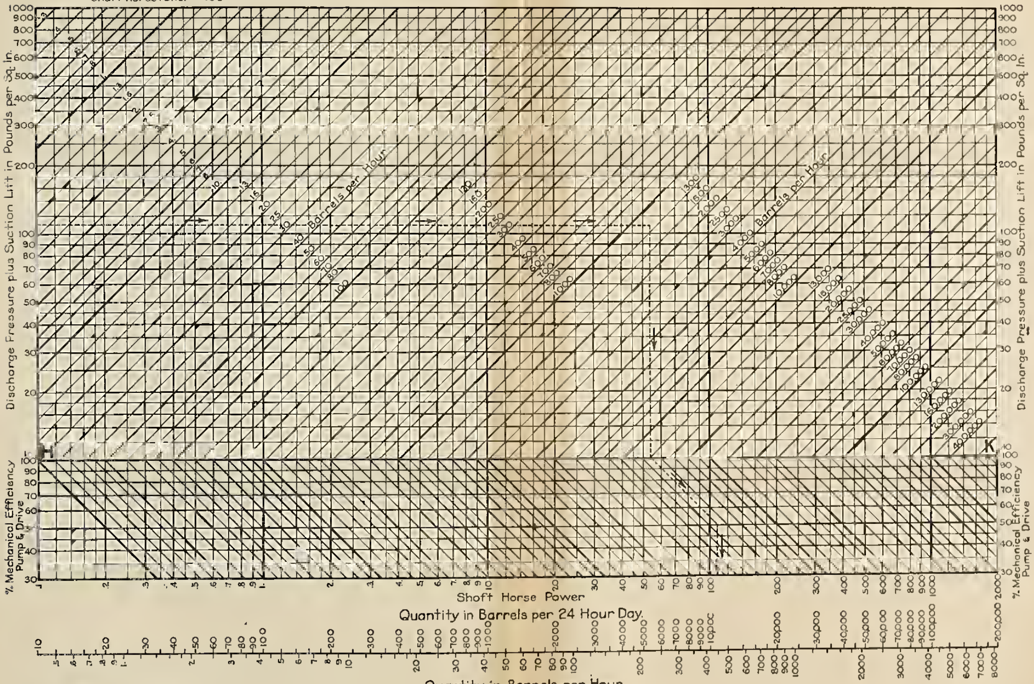
Example: Kinematic Viscosity (u/g) = .27
Baumé Gravity = 26.5°
Absolute Viscosity (u) = .24

Example: (shown by dotted lines)

Head = 110 Pounds per Sq. In.
Quantity = 1200 Barrels per Hour
Efficiency = 50 Per Cent.
Shaft Horse Power = 108

HORSE POWER CHART

(42 gal. Barrels per Hour)

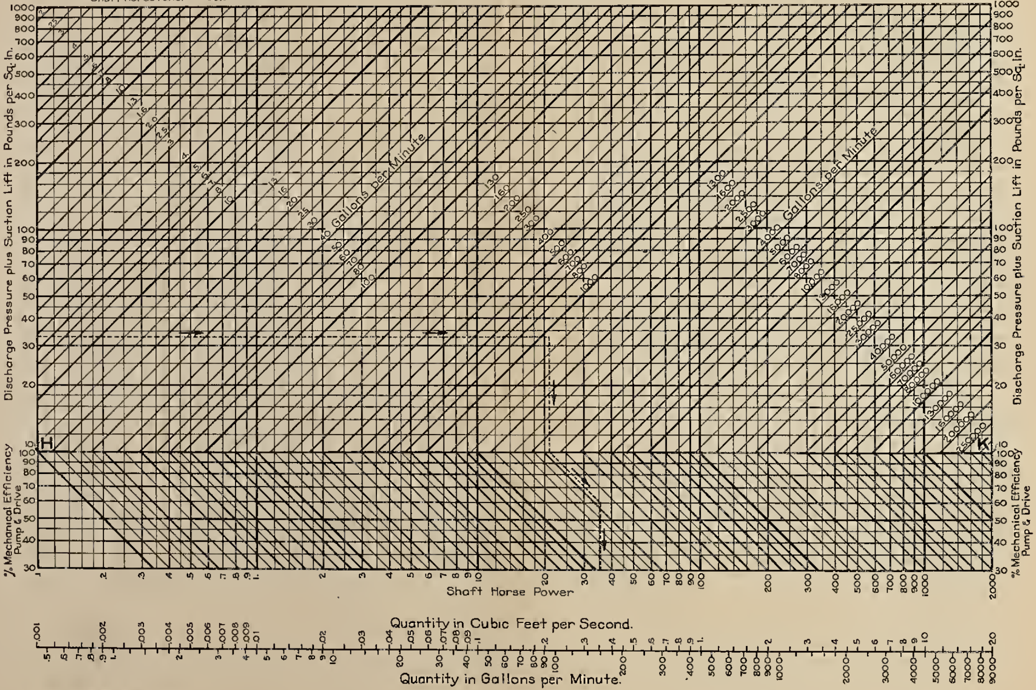


Example: (shown by dotted lines)

Head = 33 Pounds per Sq.In.
Quantity = 1100 U.S.Gallons per Minute
Efficiency = 60 Per Cent.
Shaft Horse Power = 35.3

HORSE POWER CHART

(U.S. Gallons per Minute)



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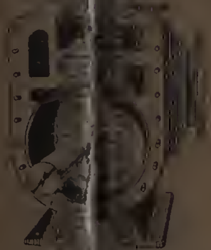

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